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THE ERYSIPHEÆ OF ILLINOIS.

BY T. J. BURRILL, PH.D., Champaign, Ill.

The Erysipheæ are microscopic fungi parasitic upon flowering plants, for the most part occurring on the leaves. They are often called "mildews" or "blights," two popular terms of very diverse application. The family is not a large one, but is well characterized and full of interest to the biologist as well as to the technical microscopist. As beautiful and popularly interesting objects under low or medium magnification nothing of the kind surpasses them, while their peculiar structure and details of life-history invite and tax, to the full capacity of trained skill, the student and investigator. The little parasites are exceedingly common objects, developing especially in late summer and autumn.

Affected leaves, like those of the common lilac, appear as if sprinkled or coated with white or gray dust. The powdery or cobwebby substance varies in all degrees of abundance and conspicuousness. Frequently the coating can be readily rubbed off, leaving the leaf apparently clean and, perhaps, not evidently injured. More often, however, the affected parts of the host plant is conspicuously injured, as shown by the discoloration or distortion of these parts. Not unfrequently the noticed injury is characteristic of the special species. Thus the leaves of the cultivated cherry tree are thickened and made inflexible, and are more or less curled under the influence of *Podosphaera oxyacanthæ*, while affected spots on maple leaves with *Uncinula circinata* retain abnormally their green color late in the season. Most often the diseased leaves become brown and die in spots and patches.

The Erysipheæ are peculiar among the leaf parasites, in that they live upon the surface and gain their stolen nutriment by sucker-like organs, called haustoria, which fit closely to the epidermis, and take through this the elaborated juices of the host by imbibition. The vegetative portion of the fungus, constituting the main part of the whitish material above mentioned, and known as the mycelium, consists of slender, branched and interlaced threads which never unite into a tissue. When fresh and growing the creeping threads resemble those of a spider's web ; when old and dry the whole mass may be easily broken up into dust.

The haustoria or suckers are short branches of the vegetative threads, and what are called asexual spores or conidia are mere joints of other modified branches. These latter arise from the creeping filaments; a cross partition forms near the apex of the young erect branch, and after a little further growth another partition, just below the first, cuts off a second cell, then a third cell is similarly formed, and a fourth, a fifth, etc., each new one below the older ones, until at length there exists an erect necklace-like row or string of pearly-white oval cells or spores. (Fig. 3, c.) These readily separate from each other and may be borne as dust in the wind. Their vitality is retained but a short time—at most only a few days. Falling upon the proper host, under the requisite conditions of moisture and temperature, they quickly germinate and reproduce the mycelium of a new plant.

The moniliform rows of spores (conidia) usually stands closely together like a miniature forest. Taken at this stage of development a bit of the affected leaf, as an opaque object under a half-inch objective and binocular tube, is an instructive and charming object. To appreciate what art can do in the pictorial representation of such an object, Tulasne's *Selecta Fungorum Carpologia* should be consulted.

At a later time in the history of the parasite a kind of fruit is produced totally unlike that just described. It is much more complicated in its structure and course of development. A process of fertilization or sexual union gives it origin as follows: A short branch of the mycelium swells to two or three times the ordinary diameter, forming an oval-shaped organ called the carpogonium, homologous with the pistil of flowering plants. From a neighboring mycelium thread another short branch, which remains slender, is sent forth and becomes the antheridium, representing a stamen of a flower. (Fig. 1, d.) This reaches the carpogonium and grows to its summit, over which the end is bent. An apical cell is separated by a partition, and at length the contents of this cell is transferred into that of the carpogonium effecting its fertilization. After this the body developes into a little sphere, with a compact, firm, cellular wall, within which are found one to several transparent sacks (each called an ascus — plural, asci), each containing two to many oval white spores. The number of asci and of spores are characteristic of genera and species. The mature spheres, named perithecia, are dark, reddish brown, or almost black, and just large enough to be seen by good unaided eyes. (Figs. 3–8.) When young they are yellow. They may be readily dissected for study by gently crushing them in water under an ordinary cover glass, pressure being made with a mounted needle, or, often better (before placing slip on stage), with the rubber at the end of a lead pencil.

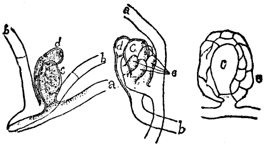

Fig. 1. Reproduction × 300.
(After De Bary).

The perithecia with their contained reproductive bodies, the spores, are destined to remain unchanged over winter, the sole surviving part of the parasitic plant. At the proper time the succeeding season the previously firm walls of the little spheres become decomposed, the spores are liberated from their prison, and being scattered by the wind, some of them fall upon their special hosts and, germinating, reproduce their kind.

One more set of structures remains to be described. Radiating from the perithecia are found thread-like organs called appendages. These vary in every way according to the species, but are always more or less distinct from the mycelium, usually of thicker diameter, firmer texture and more durable. They arise from the perithecium itself and the ends are free. In one genus these latter are simple and straight, in an other circinately coiled, in others dichotomously divided and curled in an exceedingly complicated and ornate manner. The use of these curious organs is not clearly perceived. Indeed they do not seem to be of any service, unless it is that they hold the little fruit balls in place by becoming entangled with the mycelium, a very doubtful idea. If they really have no serviceable office to fill for the plant, what explanation can the students of evolution give for their existence at all, or, in any event, why the exceedingly beautiful forms, rivaling the special ornamental appendages of animals, supposed to have been developed by sexual selection? Surely this latter principle does not apply to these fungi.

Very often there may be found in connection with the two kinds of fruits now described, a third, consisting of erect, usually somewhat flask-shape, bodies filled with simple, small spores. These organs have been supposed to be true fruits of the leaf parasite and the spores serviceable for the rapid distribution of the fungus, after the manner of the conidia above described. Certain it is the flask-like bodies arise from the same mycelium as do the conidia and perithecia. The name pycnidia is applied to them. But the acute German botanist, DeBary shows (Morph. u. Phys. d. Pilze III., pp. 53-75, Tafeln VI., VII.) that they are fructifications of a parasite dwelling inside the cells of the fungi upon which we write. This is a capital point. One who wants to verify it and, at the same time, find an object to test his skill in handling good objectives, may especially look at specimens of *Erysiphe cichoracearum*, or, as it is more commonly known, *E. lamprocarpa*, often occurring on leaves of Helianthi and Verbenæ. The accompanying figure will aid this description. Some times little spheres, exactly resembling the perithecia exteriorly, are found filled with free spores altogether similar to those of the pseudo-pycnidia. These have been accounted a fourth form of reproductive organs. (Berkley, Introduction Crypt. Bot. p. 78.) Though satisfactory proofs have not been made, it is probably also a case of parasitism, the same as just described, except as to the parts affected. DeBary names the parasite upon the parasite *Cicinobolus Cesatii*.

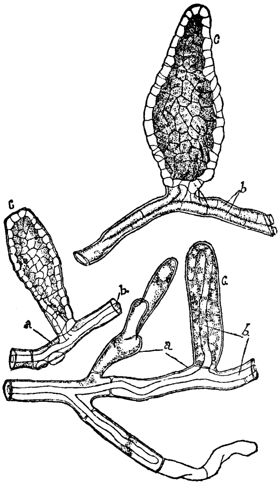

Fig. 2, Cicinobolus. ×300.
(After DeBary.)

The species of Erysipheæ affect special host plants, but many of them have a far wider range in this respect than most other parasitic fungi. The classification and identification of the species is based for the most part upon morphological characteristics, and there is a chance for acute discrimination in this matter. Many names have been given, with descriptions of supposed species, which, upon closer study, must be recognized as only slightly varying forms of previously described species. In writing up the Erysipheæ of Illinois much study of numerous specimens gathered from all quarters of the world has been given to this particular by Mr. F. S. Earle and myself. The results are summarily seen in the list of names and synonyms given herewith.

It will be observed that many forms considered as species by various authors are here included under one name,—always the first published. For the European species this condensation had already been made by Winter in his admirable *Die Pilze, Deutschlands Oesterreichs und der Schweiz*, and his work has been followed, so far as applicable, in the

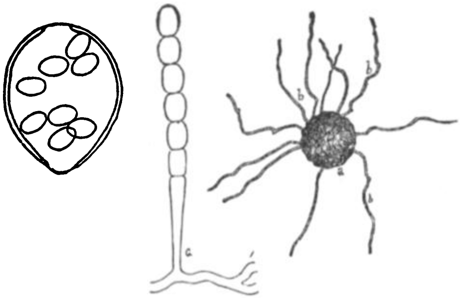

Fig. 3. Sphærotheca. ×250.

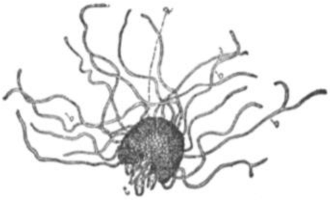

Fig. 4. Erysiphe. ×90.

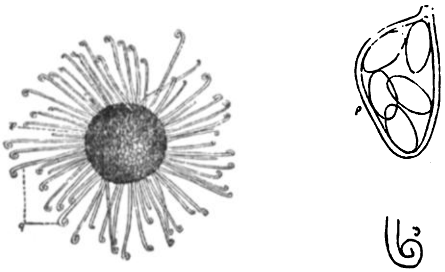

Fig. 5. Uncinula. × b 100, c and d 200.

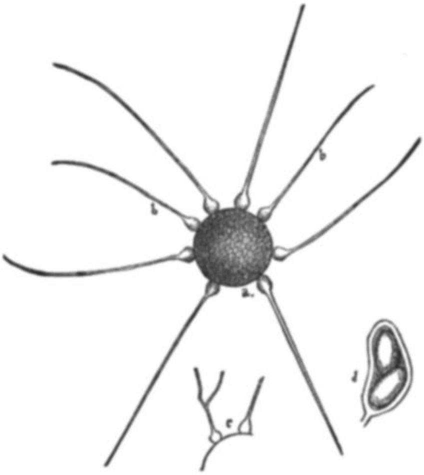

Fig. 6. Phyllactinia. ×a 50, d 100.

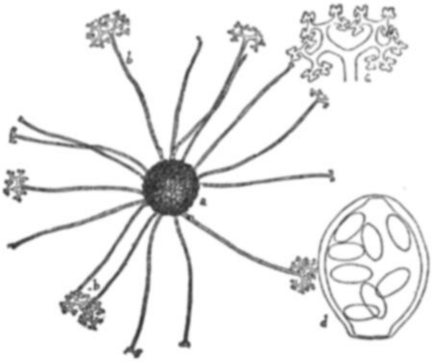

Fig. 7. Podosphera. ×a 90, c & d more.

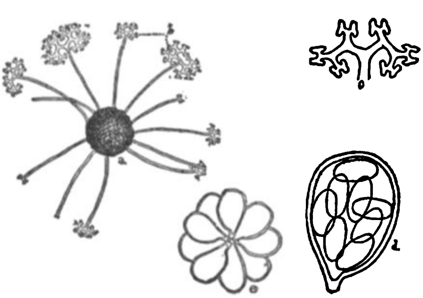

Fig. 8. Microsphæra. ×a 75, c and d more.

present paper. It remains for others to say how acceptable this may be. No new species have been described. The one on Catalapa was published by myself several years ago.

Lévillé's classification of genera is adopted and made intelligible by the following key and illustrations, the cuts for the latter being kindly loaned by the Director of the Illinois State Laboratory of Natural History.

Key to the Genera of Erysipheæ.

I. Appendages simple threads similar to the mycelium ....A.
II. Appendages conspicuously different from the mycelium ....B.
  A. Perithecium containing one ascus ....SPHÆROTHECA.
    Perithecium containing several asci ....ERYSIPHE.
  B Appendages simple (not forked) ....1.
    Appendages dichotomously forked at tip.......................2.
    1. Appendages coiled at tip, asci several ....UNCINULA.
    1. Appendages needle-shaped, asci several......PHYLLACTINIA.
    2. Perithecium containing one ascus ....PODOSPHÆRA.
    2. Peritheceum containing several asci..........MICROSPHÆRA.

LIST OF ILLINOIS SPECIES.

Spætrotheca pannosa, (Wallr) Lév.
Alphitomorpha pannosa, Wallr.
Erysibe pannosa, Link.
Eurotium rosarum, Grev.
On roses.

S. mors-uvæ, (Schw.) B. C.
Erysiphe morsuvæ, Schw.
On gooseberry and currant.

S. pruinosa C. and P.
On Rhus copallina.

S. humuli, (DC) Burrill.
Erpsiphe humuli, DC.
Sphærotheca, castagnei Lev., in part.
On Agrimonia Eupatoria.

The species are fully described in a recently-issued Bulletin of the Illinois State Laboratory of Natural History, from which this paper is largely derived. Mr. F. S. Earle must be credited with much of the preparation.

S. Castagnei, Lév.

On various Compositæ and species of Veronica, Gerardia and Brunella.

Erysiphe liriodendri, Schw.

On Liriodendron Tulipifera.

E. communis, (Wallr.) Fr.

Alphitomorpha communis. Wallr. A. horridula, Wallr., in part.
Erysibe cummunis, Rabh , E. nitida, Rabh. and E. horridula, Rabh., in part.
Erysibe communis, Link, in part.
Erysiphe aquilegiæ, DC.
Erysiphe pisi, DC.
Erysiphe convolvuli, DC.
Erysiphe polygoni, DC.
Erysiphe Martii, Lév.

On many different hosts, especially upon plants belonging to the Ranunculaceæ and Legunimosæ.

E. galeopsidis, DC.

E. lamprocarpa, Lév., in parts.
E. labiatorum, chev.

On various Labiateæ.

E. cichoracearum, DC.

Alphitomorpha communis, Wallr and A. horridula, Wallr., in part.
Alphitomorpha lamprocarpa, Schl.
Erysibe communis, lamprocarpa, depressa, horridula, Link and Rabh. in part.
Erysiphe horridula, Montagnei, and lamprocarpa. Lév., in part.
Erysiphe ambrosiæ, verbenæ, phlogis, asterum, Schw.

On many and widely different hosts, especially species of Compositæ.

Uncinula ampelopsidis, Peck.

U. Americana, Howe.
U. Spiralis, B. & C.
U. subfusca, B. & C.

On grape and Virginia creeper.

U. macrospora, Peck.

On elm.

U. flexuosa, Peck.

On buckeye.

U. circinata, C. & P.

On maple.

U. parvula, C. & P.

On hackberry.

U. salicis, (DC.) Winter.
Erysiphe salicis, DC.
Erysiphe populi, DC.
Alphitomorpha adunca, and A. guttata, Wallr.
Erysibe adunca and E. obtusata, Link.
Erysiphe aduuca, Grev.
Uncinula adunca, Lév.
Uncinula leuculenta, Howe.
Uncinula heliciformis, Howe.

On willows and poplars.

Phyllactinia suffulta, (Rebent) Sacc.
Sclerotium suffultum, Rebent.
Erysiphe coryli and E. fraxini, DC.
Erysiphe vagans, Bivon.
Alphitomorpha guttata, Wallr.
Erysibe guttata, Link.
Erysibe guttata, Fries.
Phyllactinea guttata, Lév.

On many widely different hosts, always trees and shrubs.

Podosphæra oxyacanthæ, (DC.) DeBary.
Erysiphe oxyacanthæ, DC.
Alphitomorpha tridactyla, and A. clandestina, Wallr.
Erysibe trydactyla, Rabh.
Erysibe clandestina, Link.
Podosphæra, Kunzei, and P. clandestina, Lév.
Podosphæra trydactyla, and P. myrtillina, DeBary.
Podosphæra myrtillina, Kunze.
Podosphæra minor, Howe.

On various hosts, mostly Rosaceæ.

Microsphæra semitosta, B. & C.

On button bush.

M. Russellii, Clinton.

On Oxalis wood sorrel.

M. diffusa, C. & P.

On several Leguminosæ.

M symphoricarpi, Howe.

On Symphoricarpus species, snowberry.

M. vaccinii, C. & P.

On huckleberry and cranberry.

M. euphorbiæ, B. & C.

On species of Euphorbia.

M. Erinophila, Peck.

On the "erineum" (Phytoptus galls) of beech.

M. Ravenelii, Berk.

On honey locust and other Legunimosæ.

M. Alni, (DC.) Winter.
Erysiphe alni and E. betulæ, DC.
Alphitomorpha penicillatum, Wallr.
Erysibe penicillata, Link.
Erysiphe viburni, Duby.
Erysiphe ceanothi, E. viburni, and E. syringæ, Schw.
Microsphæra Hedwigii, M. penicillata, and M. Friesii, Lév.
Microsphæra platani, Howe.
Microsphæra Van Bruntiana, Gerarde.
Microsphæra viburni, Howe.
Microsphæra pulchra, C. & P.

On many different hosts,—Ceanotaus, Euonymus, Viburnum, Ulmus, Syringa, (lilac), Platanus, Carya, etc.

M. quercina, (Schw.) Burrill.
Erysiphe quercinum, Schw.
Microsphæra extensa, C. & P.
Microsphæra abbreviata, Peck.

On oaks.

M. elevata, Burrill.

On Catalpa.